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1974 PROGRESS REPORT

PLANT PRODUCTIVITY AND NUTRIENT INTERRELATIONSHIPS OF PERENNIALS IN THE MOHAVE DESERT

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US/IBP DESERT BIOME
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ABSTRACT

Various studies of aspects of perennial plant productivity, most of which relate to the carbon budget for the northern Mohave Desert, were continued in 1974. Carbon dioxide fixation and transpiration measurements, as in previous years, were made with a modified Siemens chamber. The studies were extended to stems in 1974. Net photosynthetic rates of leaves generally decreased as temperature increased, but there was some evidence for acclimation to the increased temperatures. Only *Larrea tridentata* gave positive values for stem photosynthesis. Stem respiration for Mohave Desert plants was similar to data found in other deserts. As in other years, drought-deciduous species had higher maximum transpiration rates than did drought-resistant species. Below-ground biomass was determined with the procedures used here in 1973. A larger value for the below-ground biomass than heretofore obtained was observed due largely to inclusion of fine organic debris floated out with the saturated $MgSO_4$ method. There is some question as to the immediate origin of this material. Also, this method for determining below-ground biomass does incur large error components (standard deviations were as high as 80% for some of the soil volumes). Stem length and diameter were measured for four species over the growing season. The diameters did not appear to change, but there might have been a slight increase in stem length. In April and May of 1973, 24 individual plants were exposed to $^{14}CO_2$ with techniques previously used in this project. Seven to eight months later, part of the plants were partially excavated and counted by plant part for ^{14}C. The remainder of the plants were excavated at 13 months. The results indicated that from 3 to 20% of the carbon for leaves in the next year came from stems and roots. Nearly all the root segments were labeled at sampling time at close to uniform amounts. However, some of the roots were labeled at higher amounts than others and some were labeled at much lower levels. Some roots had very little ^{14}C and these are assumed to be very new roots rather than dead roots because, in general, of their small size. The roots with high levels of ^{14}C are assumed to be formed near the time of labeling and those with low levels to be formed after the time of labeling. From 17 to 65% of the ^{14}C fixed was recovered after 7 to 13 months.

INTRODUCTION

This project is part of a continuing study to determine the productivity and overall carbon budget of the major shrubs in a northern Mohave Desert ecosystem. The results of this study will be used to test and refine photosynthesis and whole ecosystem models which are now being developed by the US/IBP Desert Biome.

In 1974, gas exchange rates of leaf and stem material were measured for four shrub species. Rough estimates were made of the stem maintenance costs in relation to the total carbon assimilated by the leaves. Assimilate translocation studies show carbon storage and movement in shrubs growing in the field throughout the year.

Below-ground and above-ground biomass are compared for two years, 1973 and 1974. Determinations of soil ATP concentrations were made and will be related to below-ground biomass and season. These data, in conjunction with soil fauna density estimates, will be used to obtain a better understanding of decomposition in deserts.

Additional information was obtained for assimilate translocation in a ^{14}C method.

OBJECTIVES

Our primary objectives for 1974 were to continue with gas exchange, below-ground biomass and activity, and translocation studies.

During 1974 we determined:

1. CO_2 exchange and transpiration rates for leaves and stems as a function of temperature. These measurements were obtained for four desert shrub species growing under natural field conditions during the spring and early summer.
2. Below-ground biomass and total soil ATP and their change in relation to season, soil depth and distance from shrubs.
3. Translocation of ^{14}C assimilated and its partitioning and redistribution in naturally growing shrubs.
4. Changes in stem diameter and length between April and July for four shrub species.

METHODS

Field studies were carried out at two locations on the Nevada Test Site in the northern Mohave Desert, 100 km NW of Las Vegas, Nevada. The Rock Valley research area, 24 km W of Mercury, Nevada, is a US/IBP Desert Biome validation site and its characteristics are given in Turner et al. (1973) and in Turner and McBrayer (1974). The Mercury Valley site, 7 km SW of Mercury, Nevada, is a *Larrea-Ambrosia* vegetation type (Beatley 1969) with the addition of scattered individuals of *Yucca schidigera* Roezl ex Ortgies. Analysis was performed at the CETO laboratory in Mercury, Nevada, and at UCLA.

CO_2 Exchange and Transpiration

Gas exchange determinations for *Larrea tridentata*, *Krameria parvifolia* Benth., *Ambrosia dumosa* (Gray) Payne and *Lycium andersonii* Gray were carried out in Mercury Valley during the spring and early summer of 1974 (DSCODES A3UBD02, 07). Carbon dioxide fixation and transpiration measurements, as in previous years, were made using a modified Siemens chamber (Koller 1970). Stem and leaf responses to various temperatures were obtained while CO_2 concentration and relative humidity were held constant (A3UBD02, 07).

Other parameters measured include radiation in the 400-700 nm range inside the chamber using a filtered photocell calibrated against an Eppley pyranometer, plant tissue water potentials acquired using a Scholander pressure bomb, leaf temperatures using fine-wire thermocouples and tissue dry weights.

Attempts were made in 1974 to determine the gas exchange rates of stems in order to estimate the maintenance cost of these structures.

Below-Ground Biomass

Total below-ground biomass sampling in Rock Valley was continued in 1974 (A3UBD21). This portion of our study used the same sample sites and procedures for obtaining soil samples as those of Edney et al. (1974) for arthropods and Freckman et al. (1974) for nematodes. Nine soil samples were taken from the vicinity of each shrub. The sample locations encompassed an area from the shrub base to a distance of three shrub radii from the base and from the soil surface to a depth of 30 cm (Fig. 1). Detailed descriptions of the sampling procedures are reported in Bamberg et al. (1974a, 1974b).

Soil samples were taken to the CETO laboratory for processing. Two and one-half liters of soil were sieved dry through a 10-mm sieve to obtain large roots. Then a 300-ml subsample was passed wet through 2-mm and 0.5-mm sieves for medium and small roots. Fine organic matter was further separated from inorganic debris by flotation in a saturated $MgSO_4$ solution. An attempt was made to distinguish between small roots and organic debris in the fine organic matter category. Three samples from each of these nine locations, with six subsamples per sample, were examined under a dissecting scope and the percentage of small roots estimated. All roots were washed with water, oven-dried and weighed.

Root biomass per liter of soil was converted to an area basis so that below-ground biomass for Rock Valley could be estimated. The basic methodology used is described in Bamberg et al. (1974a). The only change made was that the coverage of shrubs other than those sampled was taken into consideration. Table 1 shows the new area estimates on which this year's report is based. Mean biomass/volume values for the four species studied were used for the calculation of below-ground biomass estimates for other Rock Valley shrubs.

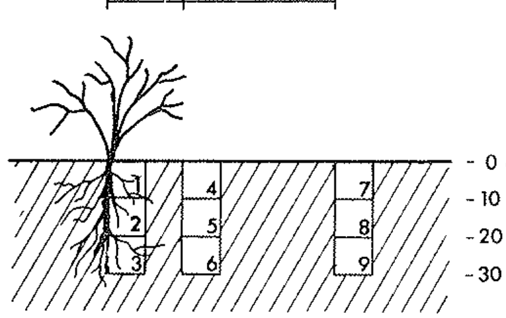

Figure 1. Graphic representation of root and ATP sample locations.

Table 1. Estimates of areas associated with shrubs in Rock Valley: shrub bases pertain to root sample loci 1, 2 and 3; samples 4, 5 and 6 pertain to areas beneath shrub canopies; sample loci 7, 8 and 9 pertain to interspaces

Species	Cover (%)	Proportional coverage	Shrub base area (m^2/ha)	Shrub canopy area (m^2/ha)	Associated interspaced area (m^2/ha)
Ambrosia dumosa	3.20	0.160	107	213	1280
Larrea tridentata	4.06	0.202	135	271	1616
Lycium andersonii	3.85	0.192	128	257	1536
Krameria parvifolia	3.82	0.190	127	255	1520
Other shrubs	5.13	0.256	171	342	2048

As in 1973, ATP was extracted from each soil sample by a Tris buffer technique, frozen and shipped to Dr. B. S. Ausmus at Oak Ridge National Laboratory for analysis. Due to equipment problems and a large backlog of samples, the soil extracts have not yet been analyzed.

Stem Growth

In mid-April 1974, stem diameters and lengths were determined for *Ambrosia dumosa*, *Ephedra nevadensis* Wats., *Krameria parvifolia* Benth. and *Larrea tridentata* in Rock Valley (A3UBD10). Ten individuals of *E. nevadensis* were selected and four stems per plant were labeled and measured. Diameters of old live stems were determined for internode areas with a micrometer. The stem length from the shrub base was then taken. When branching occurred, the longest branch was measured. The same stems were then remeasured in mid-July and changes in the dimensions calculated.

^{14}C in Roots of $^{14}CO_2$-Labeled Plants

In May 1973, 24 perennial plants in Rock Valley and Mercury Valley, Nevada, were exposed to $^{14}CO_2$ with the technique previously used in these studies (Bamberg et al. 1973, 1974b; Wallace et al. 1974, in press). Part of these plants (approximately half) were removed from the soil and separated into individual roots, stems and leaves in December 1973 and January 1974 (during the dormant season). The rest of the plants were removed in June 1974 and treated similarly. Activity of ^{14}C and weights of plant parts were obtained for all plants. The assumptions about root weight used previously (Wallace et al. 1974) were also used in this study (A3UBD11, 12).

This experiment had several purposes. One was to ascertain an estimate of the amount of reserve carbon material from stems and/or roots that was transported to new leaves in the spring growth flush. Another was to determine if a short-time $^{14}CO_2$ application resulted in a "pulse" of ^{14}C in any of the roots. Another was to determine if newly fixed ^{14}C was uniformly distributed in roots. Still another purpose was to identify, if possible, the new roots developed in the second season since the $^{14}CO_2$ treatment. Caldwell et al. (1974) have made extensive use of ^{14}C-labeling techniques.

CO_2 Evolution from Soil

Two methods were tried in 1974 to measure total CO_2 given off from soil. These methods used a KOH solution as 1) a passive absorption agent or 2) an active absorption agent.

In the passive absorption, 50 ml of 0.5 *M* KOH were placed in a petri dish under an inverted plastic chamber covering 520 cm^2 and allowed to absorb CO_2 given off from the soil for 24 hr. The KOH solution was then titrated with 0.1 *N* HCl and mg CO_2 absorbed calculated. This method worked partially in early spring, although results were highly variable and of questionable value. By June, temperatures were high enough in the plastic chamber so that no absorption of CO_2 took place. This method is not feasible in the desert because CO_2 combines with $CaCO_3$ and H_2O.

In the active absorption method, nitrogen was passed at a slow rate for a specific time, through an inverted chamber over the soil surface and bubbled through three flasks containing 0.5 *M* KOH, which was then titrated. This method was also unsuccessful since the quantity of KOH used was too large and not enough CO_2 was absorbed to measure. There are other problems associated with these two methods.

RESULTS AND DISCUSSION

CO_2 Exchange

The effects of air temperature on the net photosynthetic rates of four desert shrub species were studied throughout the spring and early summer of 1974. The warm ambient temperatures (A3UTJ02) and low precipitation (A3UTJ07) during this period (Fig. 2) more closely resembled those of 1972 than of 1973.

Results of the leaf CO_2 assimilation study are given in Table 2 and Figure 3. Net photosynthetic rates generally decreased as temperature increased for all species throughout the season. The decline in rate was not as precipitous late in the growing season. This was probably due to lower assimilation rates during that period and also probably partially due to acclimation resulting from higher ambient temperatures. Temperature optima and upper thermal compensation points did not shift to higher temperatures as the season progressed and the latter decreased in some cases.

Low plant-tissue moisture tensions in June (Fig. 4) may have inhibited the ability of the plants to fully acclimate to high temperatures (Bamberg et al. 1973).

Carbon dioxide flux of intact stems was also studied in 1974. Stem gas exchange did not appear to be strongly affected by temperature (Table 3). *Larrea* was not the only species which showed CO_2 assimilation by stems (observed only during the spring in new green stems). New stems of other species probably exhibit a net CO_2 uptake for a short period too, but were not tested due to the small amount of new stem production in 1974. Stem respiration rates of the Mohave Desert shrubs are similar to those values found in a cool desert species, *Artemisia tridentata* Nutt. (Caldwell et al. 1974).

Analyses of stem gas exchange measurements indicate that the small amount of stem material usually placed in the assimilation chamber (1-2 g) does not significantly affect the leaf gas exchange data. However, due to the large amount of stem biomass per hectare, stem respiration may prove to be important when added to the total ecosystem carbon budget. For example, assume respiration rates 0.1 mg CO_2/g DW stem/hr when the shrub is active and 0.05 mg CO_2/g DW stem/hr during the dormant period. Table 4 shows estimated annual carbon loss via stem respiration and compares it to total carbon input based on net photosynthesis (Appendix A). Stem biomass and shrub phenology data are reported in the Rock Valley Validation Site reports (Turner et al. 1973; Turner and McBrayer 1974). While these stem maintenance costs are not to be taken as final, they correspond well with those of *Atriplex confertifolia* (Torr. & Frem.) Wats. (13.5%) and *Ceratoides lanata* (18.9%; Caldwell et al. 1974), with the exception of *Lycium andersonii* Gray for 1972. The drop in the relative impact of old, live-stem respiration on the shrub carbon budget in 1973 is probably due to increased carbon allocation to new structural components and their subsequent maintenance.

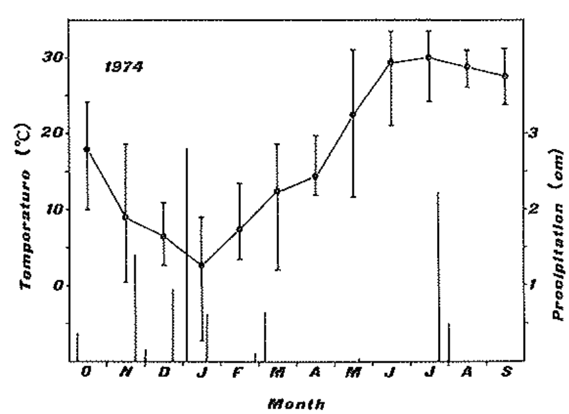

Figure 2. Mean monthly temperature with maximum and minimum daily means and weekly precipitation for Rock Valley station V during 1974 growing season.

Table 2. Effects of chamber temperature on net photosynthesis and transpiration of shrub leaf material in 1974

Species	Date	Net Photosynthesis (mg CO2/g DW leaf/hr) 20	25	30	35	40	45	Transpiration (g H_2O/g DW leaf/hr) 20	25	30	35	40	45
Ambrosia	5/01		28.8	26.4	19.2	12.6	11.8		2.3	2.5	3.1	4.2	5.8
	5/07		30.1	25.1	23.6	18.4	14.5		1.3	1.9	2.8	3.3	4.1
	5/23	17.4	12.3	10.1	5.1	4.1		0.9	0.7	1.6	1.8	2.5	4.7
Krameria	5/08	17.4	13.7	11.7	9.5	4.1	0.5	0.1	1.6	1.7	2.8	2.4	3.6
	5/29	13.0	15.8	15.9	10.7	2.8	-0.5	0.4	1.3	2.1	2.9	2.2	2.2
	7/04	3.8	4.1	3.0	0.8	1.2	-1.4			0.9	1.2	1.7	1.8
Larrea	3/30		15.3	11.4	9.0	4.2	0.6		0.5	1.9	2.5	2.4	2.9
	4/16	20.1	19.1	15.6	13.8	15.7	13.0	0.1	1.5	2.3	3.0	2.7	4.0
	5/18	10.8	13.6	10.1	6.6	3.9	1.9		0.7	1.0	1.2	1.3	1.6
	6/04		10.7	5.6	4.6	-0.2	-0.5		0.6	1.1	1.6	1.1	1.1
	6/12	8.2	5.9	4.7	4.5	4.0	1.8	0.6	0.1	0.8	1.2	1.2	1.3
	6/27		4.4	4.2	3.0	2.7	0.7		0.1	0.3	0.7	0.8	0.8
Lycium	4/12	24.4	21.1	19.6	15.0	7.1	-3.6	0.1	2.3	3.2	3.8	5.4	7.1
	4/23	21.3	17.1	16.6	11.7	7.1	6.2	0.1	1.2	1.9	2.0	2.4	3.8
	4/30	10.3	8.1	7.0	5.1	4.9	-1.1			0.6	1.8	2.3	1.6
	5/14	13.3	12.2	5.2	1.9		-2.3	0.1	0.3	0.9	0.9	0.7	1.3
	6/03		3.0	2.5		-0.4	-1.0					0.1	0.2
	6/11		-0.7	-1.4	-1.9	-1.8				0.1	0.1	0.1	

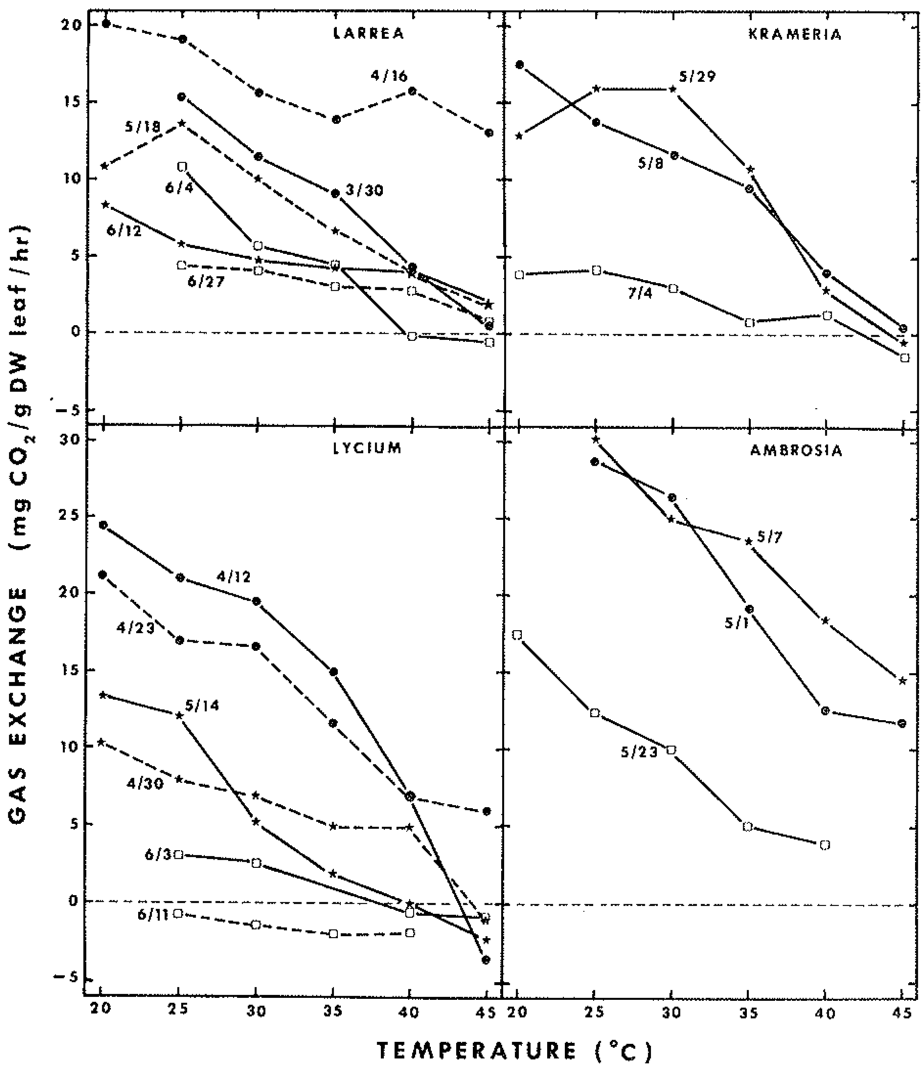

Figure 3. Effect of chamber temperature on net photosynthesis of four desert shrubs in 1974.

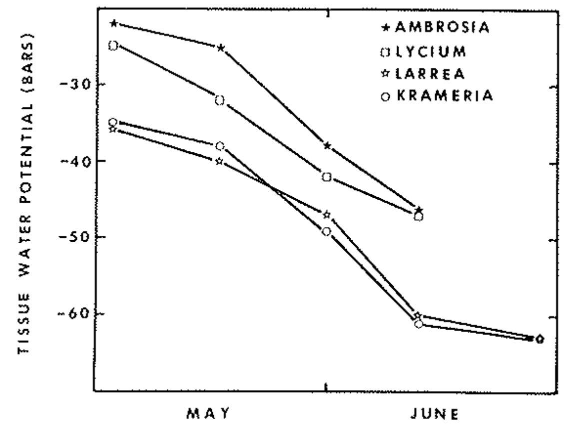

Figure 4. Plant tissue water potentials of shrubs in Mercury Valley, 1974.

Table 3. Effect of chamber temperature on the net CO_2 exchange of shrub stems (mg CO_2/g DW stem/hr) in 1974

Species	Date	Chamber Temperature (°C)					
		20	25	30	35	40	45
Ambrosia	5/02		-0.60	-0.90	-0.40	-0.30	-0.80
	5/25		-0.10	-0.10	-0.10	-0.10	
Krameria	5/29	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
Larrea	4/04	0.50	0.90	0.60	0.50	0.20	-1.00
	5/16	0.80	0.70	0.70	0.00	0.00	-0.50
	6/13		-0.10	-0.10	-0.10	-0.20	
Lycium	4/30		-0.40	-0.20	-0.30	-0.30	-0.20

Table 4. Comparison of annual stem and leaf carbon budgets for 1972 and 1973

	Year	Ambrosia	Krameria	Larrea	Lycium
Old live stem (kg DW/ha)	both	81.9	116.7	129.6	304.8
Days active	72	135	183	365	120
	73	183	213	365	152
Stem Respiration (g C/ha)	72	13.4	20.9	31.0	48.4
	73	14.7	22.1	31.0	51.7
Leaf Photosynthesis (g C/ha)	72	141.0	75.0	97.1	76.5
	73	329.2	190.8	153.7	587.7
Stem C/leaf C (%)	72	9.5	27.9	31.9	62.3
	73	4.5	11.6	20.6	8.8

Water Use

As noted in previous years, *Lycium andersonii* and *Ambrosia dumosa* (drought-deciduous species) exhibited higher maximum transpiration rates than did the drought-resistant *Larrea tridentata* and *Krameria parvifolia* (Table 2 and Fig. 5). However, late in the season as the soil moisture declined and tissue water tensions increased, *Larrea* and *Krameria* displayed higher transpiration rates than *Lycium*. Water loss of all species increased with temperature. As the season progressed, overall transpiration rates declined and the temperature acclimation was decreased.

As temperatures increased, water use efficiency (Ps/Tr) was lowered for all species (Table 5). *Krameria* and *Ambrosia* were less efficient in their water use as the season progressed, while *Larrea* failed to show any change. Late-season Ps/Tr values for *Lycium* are absent since this species exhibited a net CO_2 efflux during June. In general, it was observed that early in the season *Larrea* and *Krameria* had Ps/Tr values similar to, or slightly lower than, those of *Lycium* and *Ambrosia*. The former species, however, were able to maintain these water use efficiencies well into June, while the drought-deciduous species went dormant or exhibited "negative" Ps/Tr values.

Below-Ground Biomass

In 1974, as in the previous year, the distribution of below-ground organic matter was determined in relation to shrubs and open space. Table 6 gives the breakdown of root size classes for the nine sampling locations. As found in 1973, total root biomass generally decreased with depth and distance from the shrub. The majority of the large and medium roots (>2 mm) were confined to the shrub base. The small root category did not exhibit the precipitous decline in biomass with increased distance from the shrub as did the larger roots.

Linear regression analysis was performed to see if there was any relationship between below-ground biomass and season or shrub volume (Table 7). No correlation between root biomass and sample date was observed, as was the case in 1973. This may be due to the short growing season in 1974 compared with 1973. Attempts to study the relationship of below-ground biomass to the size of the shrub samples proved negative for both years. This is probably because all the roots in a sample were measured and no distinctions were made as to plant of origin. Error in measurement may also be involved. Large variability between samples due to spacing (Table 8) also contributed to the difficulty in data interpretation.

When analyzed by size classes, the changes in root biomass between the last two years show striking differences (Table 9). Essentially no change was noted for the larger roots, while the small roots and fine organic detritus trebled. This increase is puzzling when compared to the performance of the above-ground phytomass (Table 10). As a result mainly of this high, fine organic matter estimate, the ratio of above- to below-ground biomass appeared to almost double from 1:2 in 1973 to 1:3.8 in 1974. It must be noted that the coefficient of variation for roots in each dm[3] sampling area was from around 25 to 80%. Analysis of the fine organic matter samples revealed that roots made up only 45% of the total (Table 11). The top 10 cm of soil and the soil at the shrub base, areas of high litter accumulation, show the lowest percentage of roots. Although the differences in percent root are not significant, these data indicate that the tremendous amount of litter produced in 1973 might have had a considerable impact on the soil detritus pool.

Stem Growth

In mid-April, stem diameters and lengths were determined for four shrub species in Rock Valley. At the end of the growing season, mid-July, the same stems were remeasured to obtain changes in the dimensions (Table 12). Stem diameters for all species did not show any change. Mean values indicate that there may have been a small increase in stem length. However, the large standard deviations observed make interpretation of the findings difficult.

The small changes noted in the stem dimensions are supported by the corresponding small amount of new stem biomass found by the harvest sampling on the Rock Valley Validation Site (Turner 1975). The small changes in shrub dimensions are attributed to the low amount of precipitation during the previous winter and spring. The large variability in observed growth response seems to be an inherent problem when sampling desert vegetation. West and Gunn (1974) found high standard deviations for annual ring width, stem length and other shoot-growth parameters for Great Basin Desert shrubs. Harvey (1972) also found large variability in the seasonal shoot growth of seven shrub species in Rock Valley.

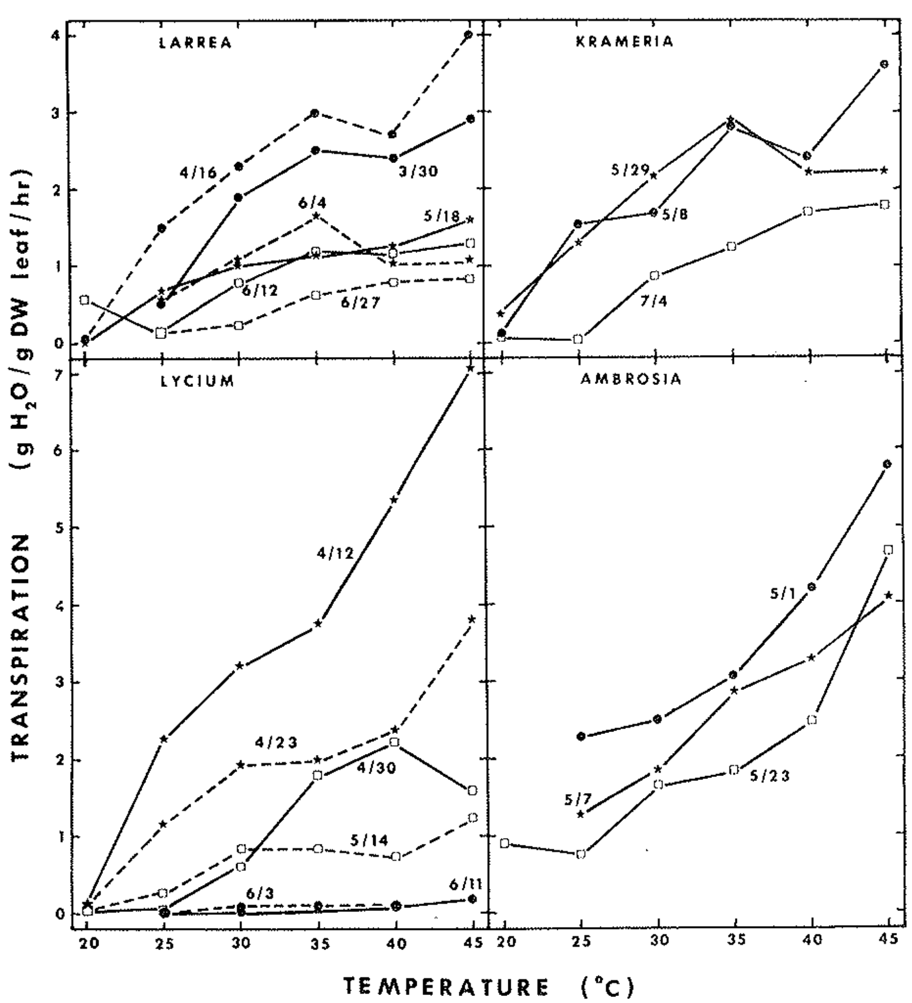

Figure 5. Effect of chamber temperature on transpiration rates of four desert shrubs in 1974.

Table 5. Effect of chamber temperature on water use efficiencies of desert shrubs during 1974 (photosynthesis/transpiration x 10^3)

Species	Date	Chamber Temperature (°C)					
		20	25	30	35	40	45
Ambrosia	5/01		12.7	10.5	6.3	3.0	2.0
	5/07		23.0	13.5	8.3	5.6	3.6
	5/23	20.0	16.6	6.2	2.8	1.7	
Krameria	5/08	133.8	8.8	7.0	3.4	1.7	0.1
	5/29	34.2	12.2	7.4	3.7	1.3	
	7/04	190.0	205.0	3.4	0.6	0.7	
Larrea	3/30		30.6	5.9	3.6	1.8	0.2
	4/16	200.0	12.6	6.8	4.6	5.8	3.2
	5/18	360.0	20.3	9.9	5.7	3.1	1.2
	6/04		18.4	5.0	2.9		
	6/12	14.4	42.1	5.9	3.8	3.4	1.4
	6/27		40.0	16.8	4.5	3.3	0.8
Lycium	4/12	203.3	9.3	6.1	4.0	1.3	
	4/23	213.0	14.9	8.6	5.9	3.0	1.6
	4/30	343.3	202.5	12.3	2.9	2.2	
	5/14	221.7	39.4	6.1	2.3	0.0	

Table 6. Root biomass (grams/liter) in relation to sample locations in Rock Valley, 1974

Species (n)		Sample Locations								
		Shrub base			Canopy edge			Interspace		
		1	2	3	4	5	6	7	8	9
Ambrosia (10)	a	14.2	06.5	03.9	00.0	00.4	01.0	00.1	00.1	00.5
	b	01.0	01.0	01.3	00.3	00.5	01.0	00.3	00.5	00.7
	c	03.2	02.9	02.7	01.7	01.6	02.1	01.3	01.4	01.5
Larrea (10)		09.0	03.7	03.2	00.4	00.4	00.8	00.2	00.2	00.4
		01.9	01.6	01.6	00.6	00.7	00.9	00.4	00.5	00.9
		04.1	03.0	02.0	02.1	02.1	01.9	01.4	01.5	01.6
Lycium (08)		14.3	04.6	04.2	00.5	00.6	01.1	00.1	00.5	00.7
		03.1	02.4	01.8	01.1	00.8	01.2	00.3	00.7	00.7
		05.6	02.9	02.7	02.2	01.7	01.7	01.4	01.6	01.6
Krameria (08)		08.2	05.6	01.8	00.0	00.4	01.0	00.0	00.4	00.4
		01.9	02.0	01.7	00.4	00.6	00.9	00.4	00.7	00.9
		04.1	02.5	02.3	02.4	01.5	01.9	01.6	01.6	01.5

[a]large roots
[b]medium roots
[c]small roots and organic debris

Table 7. Results of linear regression analysis of the effect of sampling period and shrub volume on below-ground biomass for 1973 and 1974

Species	Day vs Total Biomass		Volume vs Total Biomass	
	73	74	73	74
Ambrosia	0.01	NS	NS	NS
Krameria	0.01	NS	NS	NS
Larrea	0.01	NS	NS	NS
Lycium	0.01	NS	NS	NS

NS = not signigicant at 0.05 level

Table 8. Total below-ground biomass (g/0.01 m²) for the upper 30 cm of soil in Rock Valley in relation to shrub spacing, 1974

Species	(n)	Shrub base	Canopy edge	Interspace
Ambrosia	(10)	37.3 ± 5.9*	8.5 ± 0.9	6.4 ± 0.5
Krameria	(8)	29.9 ± 6.8	9.0 ± 1.2	7.5 ± 1.1
Larrea	(10)	30.3 ± 7.9	9.8 ± 1.1	7.0 ± 0.9
Lycium	(8)	41.6 ± 7.9	10.9 ± 2.2	7.6 ± 1.7

*mean ± standard error

Table 9. Comparison of below-ground biomass (kg/ha) in Rock Valley for 1973 and 1974

Species		Base 1973	Base 1974	Canopy 1973	Canopy 1974	Interspace 1973	Interspace 1974	Total 1973	Total 1974	% Change
Ambrosia	a	372	306	70	57	179	334	621	697	(+) 12
	b	40	93	40	124	187	639	267	856	(+) 221
Krameria		362	258	90	82	171	425	623	765	(+) 23
		52	122	62	148	187	715	301	985	(+) 227
Larrea		621	285	90	98	323	420	1034	803	(-) 29
		68	124	94	168	252	711	414	1003	(+) 142
Lycium		459	387	105	136	246	230	810	753	(-) 8
		72	145	86	144	247	936	405	1225	(+) 202
Others		624	429	122	127	316	451	1062	1007	(-) 5
		80	166	97	202	300	1004	477	1372	(+) 188
Totals		2438	1665	477	500	1235	1860	4150	4025	(-) 3
		312	650	379	786	1173	4005	1864	5441	(+) 192

a large and medium roots
b small roots and organic debris

Table 11. Analysis of small root percentage in the fine organic matter category, 2.0 < 0.5 mm, for 1974

Location	$\bar{X}$	SE
Sample #		
1	20	4.0
2	54	6.1
3	39	6.6
4	29	4.9
5	60	5.9
6	47	5.9
7	38	6.6
8	64	4.9
9	49	4.7
all	45	2.1
Area (#'s)		
shrub base (1,2,3)	38	3.8
canopy (4,5,6)	45	3.7
interspace (7,8,9)	50	3.4
Depth (#'s)		
0 - 10 cm (1,4,7)	29	3.1
10 - 20 cm (2,5,8)	559	3.3
20 - 30 cm (3,6,9)	45	3.4

Table 10. Comparison of above- and below-ground biomass (kg/ha) for 1973 and 1974

Species		Above-Ground Biomass 1973	Above-Ground Biomass 1974		Below-Ground Biomass 1973	Below-Ground Biomass 1974
Ambrosia	a	244	361	c	741	1082
	b	101	34	d	147	471
Krameria		174	174		758	1208
		106	37		166	542
Larrea		413	491		1220	1254
		54	20		228	552
Lycium		431	486		992	1304
		120	29		223	674
Others		495	797		1277	1624
		866*	93*		262	755
Totals		3004	2522		6014	9466

a old standing
b new standing
c roots
d organic debris (55% of fine organic matter)
* includes biomass of winter annuals: 674 kg/ha for 1973 and 17 kg/ha for 1974.

Table 12. Changes in stem diameters and stem lengths (mm) of four shrub species from April to July 1974

Species	(n)	Diameter	Length
Ephedra	(20)	0.08 ± 0.10*	15.5 ± 6.6
Larrea	(40)	0.03 ± 0.08	30.0 ± 7.9
Krameria	(40)	-0.10 ± 0.07	9.5 ± 6.2
Ambrosia	(40)	-0.27 ± 0.07	18.9 ± 7.1

*mean ± standard error

^{14}C in Roots of $^{14}CO_2$-Labeled Plants

The amount of $^{14}CO_2$ fixed in the 14 perennial plants exposed to $^{14}CO_2$ in Mercury Valley in May 1973 and the 10 in Rock Valley in April 1973, together with the distribution among plant parts in either December 1973 or May or June 1974, are in Tables 13 and 14. From 17 to 65% of the ^{14}C remained in the plants at sampling time as the means for time and location.

Small quantities (3 to 20%) of the ^{14}C remaining in the plants were present in the spring leaves of deciduous plants which had become defoliated in the fall and winter. This means that from 3 to 20% of the new leaf growth was derived from C coming from old stems and roots. The remainder came from new CO_2 fixation. Between December and May and June there seemed to be greater loss of the ^{14}C from roots than from leaves, but this may not be related to the transfer to the new leaves.

The distribution in segments of individual roots of the ^{14}C at sampling time, 7 to 13 months after exposure to $^{14}CO_2$, is in Tables 15 to 18. Although most roots were reasonably uniformly labeled for a given plant, some roots had higher activities than the majority and others were less labeled. The high specific activity of roots may represent roots being formed at the time of labeling, and the low specific-activity roots may be those formed after the time of labeling. Usually, each root was uniformly labeled along its length with little indication of a pulse point. A summary of the numbers of roots with low, medium and high rates of labeling is given in Table 19. There were a few roots with high label tips or high label near the point of attachment to the main root.

The fact that ^{14}C is uniformly distributed among different roots implies exchange and equilibrium.

EXPECTATIONS

In 1975 the emphasis of this project will shift to the following areas of study:

1. Respiration rates at different temperatures of nonphotosynthetic plant parts (reproductive structures, stems and roots).
2. Techniques for measuring soil respiration will be refined using an infrared gas analyzing system and respiration rate determined throughout the year. Carbon dioxide evolution from the soil surface will be measured in relation to soil moisture and temperature, and location with reference to shrubs. Respiration rates of soil from various depths will be determined for different temperature and moisture regimes.
3. Some shrub CO_2 exchange studies will be conducted on a limited basis to study the effect of nitrogen and water amendments. This series of tests will be done in conjunction with the nitrogen process study of Romney and Wallace.
4. Additional work will be done to better understand below-ground dynamics.
5. Synthesis of the information will be started.

Table 13. ^{14}C status of plants from Mercury Valley, Nevada, exposed to $^{14}CO_2$ in May 1973

Species	Initial total ^{14}C fixed x 10^3	Roots	Stems	Leaves	Total	Roots	Stems	Leaves	Roots	Stems	Leaves	Root / root + stem	g new leaves that could have come from roots or stems
		% of ^{14}C fixed remaining				Relative distribution of ^{14}C			Dry weight, g/plant				
	cpm											%	
						Excavated in December 1973							
Larrea tridentata	2529	10.3	14.7	12.8	37.8	27.2	38.9	33.9	21.0	21.2	8.8	49.8	-
Atriplex confertifolia	3340	3.0	18.9	18.4	40.3	7.4	46.9	45.7	20.2	44.2	45.4	31.4	-
Ambrosia dumosa	2095	5.2	7.1	4.3	16.6	31.3	42.8	25.9	45.9	69.9	10.0+	39.6	-
Krameria parvifolia	622	14.1	51.7	0.0	65.8	21.4	78.6	0.0	120.4	95.5	0.0	55.8	-
Atriplex confertifolia	2051	2.9	21.8	11.2	35.9	8.1	60.7	31.2	12.1	26.0	12.1	31.8	-
Ambrosia dumosa	1621	9.7	53.9	0.7	64.3	15.1	83.8	1.1	29.2	26.0	4.3	52.9	-
Acamptopappus shockleyi	1343	7.6	45.8	0.0	53.4	14.2	85.8	0.0	15.6	28.0	0.0	35.8	-
Larrea tridentata	2690	11.8	16.1	8.3	36.2	32.6	44.6	22.8	85.0	92.0	16.0	41.0	-
Means	--	8.1	28.8	5.8	44.9	19.7	60.3	20.0	-	-	-	46.6	-
						Excavated in June 1974							
Larrea tridentata	835	7.3	7.6	4.9	19.8	36.9	38.4	24.7	128.8	122.7	62.0	51.2	15.3
Atriplex confertifolia	2600	3.5	20.5	5.7*	29.7	11.7	69.0	19.2*	87.6	137.0	123.0	39.0	23.6*
Ambrosia dumosa	914	5.2	41.8	8.9*	55.8	9.3	74.9	15.9*	47.0	65.1	16.1	41.7	2.6*
Ambrosia dumosa	2039	8.7	25.6	3.4*	37.7	23.1	67.9	9.0*	75.6	76.0	43.0	49.9	3.9*
Ambrosia dumosa	2022	ND	46.2	8.0*	ND	ND	ND	ND	ND	70.0	37.9	ND	ND
Acamptopappus shockleyi	1277	3.9	23.7	6.5*	34.0	11.5	69.7	19.1*	25.1	35.2	22.2	41.7	4.2*
Means	--	5.7	27.6	6.7*	35.3	18.5	64.0	17.5*	-	-	-	44.7	-

*These values represent retranslocation from old stems and roots to new growth.
ND is not determined.
+ leaves were dead.

Table 14. ^{14}C status of plants from Rock Valley, Nevada, exposed to $^{14}CO_2$ in April 1973

Species	Initial total ^{14}C x 10^3 cpm	Roots	Stems	Leaves	Total	Roots	Stems	Leaves	Roots	Stems	Leaves	Root / root + stem %	g new leaves that could have come from roots or stems
		% of ^{14}C fixed remaining				Relative distribution of ^{14}C			Dry wt, g/plant				
Excavated in December 1973													
Lycium andersonii	960	40.4	31.9	-	72.3	55.9	44.1	-	103.9	77.1	-	57.4	-
Grayia spinosa	999	26.9	34.2	-	61.1	44.0	56.0	-	76.4	58.5	-	56.6	-
Ceratoides lanata	2397	10.5	21.5	3.1	35.1	29.9	61.3	8.8	20.6	17.0	14.9	54.8	-
Atriplex confertifolia	2092	7.9	23.7	10.7	42.3	18.7	56.0	25.3	26.1	56.0	20.0	31.8	-
Lycium pallidum	909	29.4	28.3	-	57.7	51.0	49.0	-	59.9	18.6	-	76.3	-
Means	-	23.0	27.9	-	53.7	39.9	53.3	6.8	-	-	-	55.4	-
Excavated in May 1974													
Lycium andersonii	988	26.9	29.5	1.3*	57.7	46.6	51.1	2.3*	87.9	99.4	15.7	46.9	0.4*
Grayia spinosa	1226	13.3	39.4	7.3*	60.0	22.2	65.0	12.2*	51.2	77.1	23.5	39.9	2.9*
Ceratoides lanata	1959	13.6	44.6	4.9*	63.1	21.6	70.7	7.8*	112.3	114.3	21.8	49.6	1.7*
Atriplex confertifolia	2193	4.6	12.8	2.9*	20.3	22.7	63.1	14.3*	40.4	58.7	25.3	40.8	3.6*
Lycium pallidum	792	19.8	16.4	1.0*	37.2	53.2	44.1	2.7*	147.6	36.3	5.7	80.3	0.2*
Means	-	15.6	28.5	4.0*	47.7	33.3	58.8	7.9*	-	-	-	51.5	-

*These values represent retranslocation from old stems and roots to new growth following dormancy.

Table 15. Distribution of ^{14}C in roots of plants from Mercury Valley, Nevada, excavated seven months following exposure of leaves to $^{14}CO_2$ (see Table 13)

Larrea tridentata - Mercury Valley - December 1973 (2,690,000 cpm ^{14}C fixed)

Root	Depth from surface cm	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	Dry weight of roots g
		Length of root, cm — cpm/g dry weight											
Main	-	4580	8280	2740	2480	2080	1960						18.16
A	2	2640	2480	3220	3760	3800	3840	4080	5620				2.99
B	3	2500	2420	2740	2860	4300	4020	3780					4.61
C	2	760	920	1320	1300	1300							0.33
D	6	2720	2860	3140	3220	3340	3020	2840	2920				3.12
E	7	4000	3820	3780	3920	4600							0.54
F	2	2760	2460	2080	2100	2180	2020	1840					1.62
G	10	2220	2180	2120	2300	3040	2520	1960					4.11
H	3	3940	6050	8020	9040								1.65
I	8	2980	2900	3120	3300	3240	3080	3680	3840	3740	3600	3540	8.01
J	11	2280	2080	2240									2.09
K	9	6160	6380	6200	6680								1.97
L	3	4660	4520	2220	4040	4260	3640	3600	3500	3360			12.88
M	5	6680	6960	6560	6220	5520	5180						3.13
N	6	5340	4540	4420	4460	4280	4120	4180	4280				0.82

Misc. and fine roots 1140 cpm/g dry wt (7.8 g); litter 4640 (23.4 g); leaves 13,920 (16.0 g); stems 4720 (92.0 g).

Atriplex confertifolia - Mercury Valley - December 1973 (3,340,000 cpm ^{14}C fixed)

Root	Depth from surface cm	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	Dry wt of roots g
		Length of root, cm — cpm/g dry weight									
Main	-	3440	2440	2460	2920	3880	4060				10.77
A	4	2400	2200								0.31
B	8	11020	13280	12100	13000	12560	13280	12980	12020	12050	0.19
C	8	6980	7000	8200	10580	10360	10220	11060	10200		0.15
D	6	22820	16800	14200	15420	16200	17000	15210	15280	19200	1.03
E	4	3080	3000	2980							0.30
F	22	1100	1220								0.27
G	20	5980	5820	5700	5600	5460					0.33
H	30	2100	2160	2170	2220						0.24
I	off D	720	780	720	340	220					0.34
J	27	2340	2200	2080	2610	2740					2.11
K	29	2040	1760	1780							0.11

Fine roots 4820 cpm/g dry wt (0.2 g); crown pieces 2100 (3.9 g); dead stump 200 (14.9g); misc roots 3000 (1.3 g); litter 9540 (30 g); leaves 13520 (45.4 g); stem 15420 (40.3 g).

Table 15, continued

Ambrosia dumosa - Mercury Valley - December 1973 (1,621,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm										Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
	cm	cpm/g dry weight										g
Main	-	5320	6340	6500	7820	4920						10.70
A	9	5840	6080	6160								0.19
B	9	8780	8080	7700	7280	5500	4820					0.99
C	9	5640	6800	5500	5580	6000	6440	5200	4860	6050	7640	4.51
D	11	4520	4960	5520	5500	5660	4320	4860	5620			2.56
E	18	5860	5960	5780	6200	6520						1.13
F	16	3820	4200	4620								0.71
G	19	1216										0.19
H	25	7140	7500	8460	5940							9.80

Misc. and fine roots 2020 (3.6 g); litter 16540 (4.9 g); no leaves; stem 33600 (26.0 g).

Atriplex confertifolia - Mercury Valley - December 1973 (2,051,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm					Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	
	cm	cpm/g dry weight					g
Main	0	6720	4500	4960	5100	3900	6.91
A	4	8540	9480	17800			0.11
B	9	4240	6020	7433	7680	9000	0.33
C	11	4180	4020	3800	3720		0.87
D	25	3960	4020	4160			0.30

Misc. and fine roots 2700 cpm/g dry wt (1.9 g); litter 13,680 (10.3 g); leaves 19,000 (12.1 g); stems 17,100 (26.0 g).

Ambrosia dumosa - Mercury Valley - December 1973
(2,095,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm				Dry wt of roots
		0-10	10-20	20-30	30-40	
	cm	cpm/g dry weight				g
Main	-	1120	840	1220	720	25.28
A	6	2460				0.04
B	10	640	760	660		2.11
C	10	940	1080	1200		1.26
D	10	1800	1600	1580		0.78
E	10	1760	1800	2720		0.63
F	11	1140	1220	1300	760	0.60
G	13	1740	2440	2020		0.85
H	10	1640	1760	2020		0.99
I	15	3100	3840	4940		1.09
J	15	1900	1680	2220		0.58
K	17	860				0.13
L	20	200	120	100	20	1.24
M	20	1680	1960	1800	1860	0.81
N	25	100	20			0.24
O	25	160	100			0.20
P	27	500	398			0.47

Crown 1260 cpm/g dry wt (7.4 g); shoots 2880 (79.9 g); fine roots 1180 (2.3 g)

Table 15, continued

<u>Acamptopappus shockleyi</u> - Mercury Valley - December 1973 (1,343,000 cpm ^{14}C fixed)

Root	Depth from surface	0-10	10-20	20-30	30-40	40-50	Dry wt of roots
	cm			cpm/g dry weight			g
Main	-	4200	8660	3660			5.21
A	3	-	-	-	(not counted)		0.03
B	3	-	-	-	"	"	0.04
C	3	-	-	-	"	"	0.04
D	2	-	-	-	"	"	0.02
E	3	-			"	"	0.05
F	5	-	-	-	"	"	0.06
G	8	6220	5620	5420	5880	5600	1.37
H	7	14520	15220	18760			0.37
I	10	6660	8040	10060			0.73
J	10	6500	10900	8800			0.97
K	11	1560	1040	300			0.45
L	13	7880	8940				0.80
M	16	6660	9880	9860	23360		0.65
N	15	4600					0.25

(Column header "Length of root, cm" spans 0-10 through 40-50.)

Misc. and fine roots 6540 (2.0 g); Litter 5760 (2.3 g); no leaves; stem 21980 (28.0 g).

<u>Krameria parvifolia</u> - Mercury Valley - December 1973 (622,000 cpm ^{14}C fixed)

Root	Depth from surface	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
	cm				cpm/g dry weight						
Main	-	320	540	1360							
A	7	260	220	160	160	160	300	240	80	80	100
B	4	8280	8000								
C	3	12640									
D	10	980	820	680	780	1540	2010	3560	5920		
E	13	1100	620	400	340	120	40				
F	6	500	480	460	500	540	720	780			
G	14	1320	980	760	920	880	1080				
H	4	2560	2000	1460	1400	1480					
I	12	360	340	380	340	660	620	520	400	320	280
J	9	1260	1300	1720	1610	880	780	720	780	760	1160
K	12	700	620	540	600	700	760	900	2020		
L	10	740	740	780	700	720	680	720	960	1040	1020
M	7	340	280		420	680		220		300	180

(Column header "Length of root, cm" spans 0-10 through 90-100.)

Root	Depth from surface	100-110	110-120	120-130	130-140	160-170	170-180	180-190	200-250	250-300	Dry wt of roots
	cm			cpm/g dry weight							g
Main	-										56.76
A	7										3.98
B	4										0.32
C	3										0.19
D	10										2.15
E	13										1.31
F	6										1.96
G	14										1.40
H	4										0.53
I	12										6.72
J	9	1160	1160								17.13
K	12										2.54
L	10	960									4.80
M	7		220	200	180	240	360	500	300	380	32.25

(Column header "Length of root, cm" spans 100-110 through 250-300.)

Litter 7060 cpm/g dry weight (18.8 g); misc. and fine roots 660 (1.0 g); no leaves; stem 5980 (95.5 g).

Table 15, continued

Larrea tridentata - Mercury Valley - December 1973 (2,529,000 cpm ^{14}C fixed)

Root	Depth from surface (cm)	0-10	10-20	20-30	30-40	40-50	50-60	60-70
		Length of root, cm — cpm/g dry weight						
Main	-	14600	9900	3580				
A	1/10	9360	500	2440	2020			
A^1	1/10	5940	740					
A^2	1/2	67380	6360					
B	2/10	13540	6900	5240				
C	1/2	3660	2100					
D	1	21040	20620	22320	15280			
E	1/2	-	-	(not counted)				
F	3	500						
G	3	27660	23940	25120	23500	22580	23360	21560
H	13	8620	8020	9120	9000	10400		
I	20	9560	9240	9860	10720	9000	8420	

Root	Depth from surface (cm)	70-80	80-90	90-100	100-110	110-120	120-130	Dry wt of roots (g)
		Length of root, cm — cpm/g dry weight						
Main	-							7.16
A	1/10							0.67
A^1	1/10							0.10
A^2	1/2							0.17
B	2/10							0.26
C	1/2							0.16
D	1							0.72
E	1/2							0.36
F	3							0.09
G	3	21000	20280	21020	21600	21780	21760	3.50
H	13							0.72
I	20							1.87

Crown cpm/g dry wt 10,000 (2.5 g); leaf 36,860 (8.8 g); stem 18640 (21.2 g); fine roots 2740 (2.5 g).

Table 16. Distribution of ^{14}C in roots of plants from Mercury Valley, Nevada, excavated one year after exposure of leaves to $^{14}CO_2$ (see Table 13)

Larrea tridentata #4 - Mercury Valley - June 1974 (835,000 cpm ^{14}C fixed)

Root	Depth from surface (cm)	0-10	1020	20-30	30-40	40-50	50-60	60-70	70-80	80-90
		Length of root, cm — cpm/g dry weight								
Main	-	340	160	280	260	200	160	180		
A	8	920	920	920	920	920	1000	1120	1320	1000
B	10	440	440	500	660	620	940	680	1160	1200
C	30	500	520	420	440					
D	30	240	200	160						
E	33	160	160							
F	33	200	200	320	480	500	640	700	720	680
F	39	560	520	360	140					

Root	Depth from surface (cm)	90-100	100-110	110-120	120-130	130-140	140-150	150-160	170-180	Dry wt of roots (g)
		Length of root, cm — cpm/g dry weight								
Main	-									56.48
A	8	700	860	1040	920	800	860	940		28.03
B	10	1160	1100	1040	1000	860	900	800	680	7.00
C	30									1.14
D	30									0.97
E	33									0.39
F	33	640	500	280						13.00
F	39									0.45

Misc. roots cpm/g dry wt 260 (5.0 g); leaves 660 (62.0 g); small stem 1000 (26.7g); large stem 380 (96.0g)

Table 16, continued

<u>Atriplex confertifolia</u> - Mercury Valley - June 1974 (2,600,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm							Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	
	cm	cpm/g dry weight							g
Main	-	1220	1980	1620	680	740	700		30.09
A	6	100	120						0.05
B	7	200							0.06
C	14	1760	1260	1520	1340				3.78
D	16	3080	2460	2900	2300	2400			0.40
E	16	680	500	510	120				0.55
F	18	1000	1780	1040	880	920			4.17
G	22	3800	3400	4200	3000				2.50
H	24	1200	860						0.42
I	22	1200	440						0.06
J	27	720	4450						0.09
K	27	1100	1940	1340	1120				0.32
L	21	1440	1140	1140	1020	1060	920	940	2.02
M	29	1100	1325						0.15
N	19	1200	800	660	720				2.15

Misc. roots 1980 (3.9 g); leaves 1200 (123.0 g); stem 3520 (90.0 g); stem crown 20 (37.0 g); litter 2620 (83.0 g).

<u>Ambrosia dumosa</u> - Mercury Valley - June 1974 (2,039,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm									Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	
	cm	cpm/g dry weight									g
Main	-	2300	2360	2700	1840	1440	1460	1160			32.57
A	8	5520	6080	7320							1.11
B	9	3280	4340	4960	5040						0.74
C	10	3400	4160								0.26
D	8	2500	2120	1180	2180	1400					4.14
E	12	2340	2240	2400	3600						1.69
F	12	4160	3900	2680	4700	4380	4700	4380			3.81
G	14	2380	2760	2820	2640	2320	2120	2460	3300		5.59
H	12	5380	5320	4980	4580	5300	4860	4540	5240	4460	3.35
I	13	680	520	540	700						1.77
J	14	1920	1540								0.45
K	18	2640	3000	3360	3340	3700	3200	2100			5.42
L	20	3520	2260	3160							1.41
M	25	1100	1240	1240	1060	1140					1.16
N	26	1480	1120	700	680	720	1360	1278			2.52

Misc. roots cpm/g dry wt 1180(1.0g); leaves 1600 (43.0 g); small stem 9680 (27.6 g); large stem 5120(48.4 g); litter 800 (5.3 g).

<u>Acamptopappus shockleyi</u> - Mercury Valley - June 1974 (1,277,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm							Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	
	cm	cpm/g dry weight							g
Main	0	2020	1820	1720	2120	2340	2360		14.94
A	3	3930	3750	2000					0.05
B	4	2560	21000						0.04
C	5	980							0.08
D	6	1380	4000						0.07
E	5	4420							0.08
F	9	2520							0.04
G	20	1360	1300	1860	2780				0.70
H	20	2460	2680	3520					0.48
I	20	1000	960						0.30
J	20	1860	1640	2060	2320	3700	5720	5300	0.81
K	23	2120	2400	2400					0.42
L	26	2120	2740	2540	2820	3500			1.02

Misc. roots cpm/g dry wt 2360 (1.7 g); misc roots 446 (0.7 g); leaves 3740 (22.2 g); small stems 9940 (15.0g);large stems 7580 (20.1 g).

Table 16, continued

Ambrosia dumosa - Mercury Valley #7 - June 1974 (914,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm							Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	
	cm	cpm/g dry weight							g
Main	-	1420	1500	600	1020				16.68
A	10	480	880	900					1.36
B	9	1840	2060	2020					0.75
C	12	120	42						0.21
D	10	6091							0.08
E	13	1640	700	540					0.54
F	17	0	0	0	0				1.52
G	16	0	0	0	0				2.42
H	16	780	1000	760	420	240			4.45
I	18	860	900	800	560	720	660		2.65
J	16	1540	1480	1480	1120				2.65
K	16	1440	1300	1220	1220	1400	1500	2260	2.66
L	20	1260	1120	800	960	1780			0.24

Leaves 5040 cpm/g dry wt (16.1 g); small stems 22000 (15.9 g); large stems 4360 (49.2 g).

Table 17. Distribution of ^{14}C in roots of plants from Rock Valley, Nevada, excavated eight months following exposure of leaves to $^{14}CO_2$ (see Table 14)

Ceratoides lanata - Rock Valley - December 1973 (2,397,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of roots, cm									Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	
	cm	cpm/g dry weight									g
Main	-	14280	12300	10940	7920	7960	10800	12320	5260	5200	8.08
A	3	30100	26400	27200	25800						0.09
B	5	17960	17200	18800							0.12
C	9	15820	17600	18200	20740	16800					0.23
D	10	19020	19600	18100	15210	15300					1.19
E	9	16980	18900	23100	27600	22800					0.26
F	11	10180	14600	14100	33800	30000					0.11
G	14	11040	11460	10980	12100	10160					0.82
H	15	12280	11160	10060	9920	8060	7600	7480	7300		1.85

Misc. and fine roots 11000 cpm/g dry wt. (5.2 g); stems 30380 (17.0 g); leaves 22420 (14.9 g); litter 4220 (14.9 g).

Atriplex confertifolia - Rock Valley - December 1973 (2,092,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm									Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	
	cm	cpm/g dry weight									g
Main	-	8200	4740								10.13
A	9	3660	3620	4260	4320						0.42
B	5	15260	9820	4860	4700	4720					0.38
C	13	1180	1300	1100	1200						0.17
D	17	2060	2125	1820	1700						0.46
E	18	40	20								0.11
F	20	6720	6000								0.35
G	18	8980	7210	6620	6240	6000	5920				1.09
H	18	4480	4162	3200	2080	3602	3200	4060	3980	5620	2.46
I	14	2760	3000	3700	3280	3620	2810	2300	2500		3.35

Litter 12720 cpm/g dry wt (13.3 g); misc. & fine roots 4240 (3.8 g); stem 8860 (56.0 g); leaves 11220 (20.0 g).

Table 17, continued

Lycium pallidum - Rock Valley - December 1973 (909,000 cpm ^{14}C fixed)

Root	Depth from surface	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110-120	Dry wt of roots
		Length of root, cm												
	cm	cpm/g dry weight												g
Main	-	3460	3780	4016	3910	3880	4520	4620	5120	5000	4500	3020		28.50
A	3	1660	1580											0.09
B	6	1400	1400											0.23
C	8	4120	2620	2420	1700	1680	1640							0.65
D	8	2740	2700	1720	1700	420	302							0.45
E	10	2810	2740											0.08
F	12	6860	6600											0.12
G	18	4440	4000	4300	4820	5060	4340	2800	2700					2.61
H	33	1360	1400	1800										0.57
I	40	4920	5420	7860	6040	3540	4040	4200	4460	4700	4640	3820	3700	7.63
J	45	5560	4980											0.17
K	55	5420	5210	5200	5000	4880								1.19
L	36	7860	7520	7660	7840	7900	9500	9400	9020	8300				1.56

Dead crown material 20 (68.4 g); live crown material 5400 (5.1 g); live roots 2800 (0.4 g); stems 4280 (13.5 g) litter 6180 (4.7 g); miscellaneous roots 2560 (7.9 g).

Grayia spinosa - Rock Valley - December 1973 (999,000 cpm ^{14}C fixed)

Root	Depth from surface	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	Dry wt of roots
		Length of root, cm								
	cm	cpm/g dry weight								g
Main	-	4240	5140	3640	2560	2660				17.99
A	5	960	40							0.13
B	5	5120	3620	3500	3460	3480	3420	3460	3410	5.03
C	4	12280	11680	12100	11920	13400	16320			0.84
D	5	9840	8120	6600	5580	4440	4310	4014		3.86
E	13	9260	9410	9600	9980	9620	8240	9210	10460	2.26
F	5	23140	22160	21000	19800	19820				0.76
G	10	2660	2600	2560	2300	2160	3000	3500		0.41
H	15	60	60	0	0					0.20
I	19	5400	5480	5180	6900	7800				1.75
J	30	2720	2600	2580	2260	2020				1.41
K	40	2080	1960							0.25
L	38	2580								0.25
M	35	2280	2200	2420	2580	2620				3.17

Misc. and fine roots cpm/g dry wt 1040 (28.1 g); litter 9580 (12.9 g); stem 5780 (55.8 g).

Lycium andersonii - Rock Valley - December 1973 (960,000 cpm ^{14}C fixed)

Root	Depth from surface	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
		Length of root, cm							
	cm	cpm/g dry weight							
Main	-	1020	900	720	700	700	880	750	600
A	6	11320	11000	11900	12000	13320			
B	6	220	180	40	50	60			
C	16	3000	3000	3200	3100				
D	15	2140	2240	2060	2100	2300	2500	3060	2980
E	13	1260	1420	1740	1920	2320	3300	4260	
F	3	10280	8850	8170	6080	6280			
G	24	360	240	180	40	60	40		
H	4	2700	2680	2660	2640	2540	2400		
I	8	1820	1780	2060	2180	2400	2200	2160	
J	8	2860	2380	2000	2240	1900	3660		
K	3	5980	5400	4260	4820	5560	7900	8020	8140
L	3	5320	5100	6140	6320	7220	7260	8900	11020
M	10	11080	7820	6400	4840	4520			
N	3	60	80	80	140	240	180	320	180
O	20	160	100	100	80	0	40	200	360
P	5	2080	3000	4720	4700	4680	3800	3680	3700

Table 17, continued

Lycium andersonii - Rock Valley - December 1973 (960,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm							Dr wt of roots
		80-90	90-100	100-110	110-120	120-130	130-140	140-150	
	cm	cpm/g dry weight							g
Main	-	860	750	700	620	190	600	280	39.31
A	6								1.05
B	6								1.02
C	16								1.16
D	15	2620							2.63
E	13								5.57
F	3								0.48
G	24								4.14
H	4								1.05
I	8								5.45
J	8								1.27
K	3	9060	9960	13240					7.37
L	3	8000							2.62
M	10								0.24
N	3								10.73
O	20	100	80	60					2.47
P	5								3.05

Stem crown materials 2120 (34.3 g); dead main root 5020 (35.5 g); litter 1700; stem 4820 (42.8 g).

Table 18. Distribution of ^{14}C in roots of plants from Rock Valley, Nevada, excavated one year after exposure of leaves to $^{14}CO_2$ (see Table 14)

Atriplex confertifolia - Rock Valley - May 1974 (2,193,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm								Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	
	cm	cpm/g dry weight								g
Main	-	2660	3200	2140	1560	1440	1380			24.10
A	7	1009								0.08
B	10	1480	1840	1610						0.24
C	9	4370	6770	6200	6100	6000				0.19
D	9	8700	7670	10520	9370	17435	21200			0.26
E	8	1020	1230	1650	1920	2570				0.23
G	18	1620	3760	4840	8430	8080				0.96
H	7	1900	1740	1280	1200	1120	1020	1020	700	2.48
I	18	1240	1140	900	920	1180	1060	660		1.13
J	15	2560	2340	2100						0.49
K	13	6860	7060	8720	8500	6920	6700	6040		1.05
L	16	2460	880							0.33

Misc. roots cpm/g dry wt 1340 (3.6 g); large stem 5340 (25.9 g); small stem 4380 (32.8g); leaves 2540 (25.3 g); litter 10820 (13.8 g).

Grayia spinosa - Rock Valley - May 1974 (1,226,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm										Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
	cm	cpm/g dry weight										g
Main	-	2580	2260	1500	1660	1320	1300	1360	1480	1740	2320	20.98
A	5	3720	3520	3400	3460	3080	2545					1.17
B	4	2920	1740	5962								0.24
C	5	7830	3043									0.09
D	6	2310	1130									0.11
E	5	2840	1882	643	93							0.23
F	7	3820	3100	2920	2200	2400	2280	2300				9.94
G	5	8960	7960	5940	4980	3980	4620					4.60
H	11	3220	2840	3540	5820							0.93
I	9	4160	4500	2900								1.23
J	12	2680	2680	2340								1.20
K	13	3780	3040	2050								0.26
L	17	1700	1680	2060								0.42
M	21	1980	1300									0.20

Misc. root cpm/g dry wt 4320 (2.9 g); small stem 4200 (28.2 g); large stem 7440 (48.9 g);leaves 3780 (23.5g). litter 160 (41.3g).

Table 18, continued

<u>Ceratoides lanata</u> - Rock Valley - May 1974 (1,959,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm										Dry wt of roots
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
	cm	cpm/g dry weight										g
Main	-	3500	2000									26.28
A	7	4000	4710	18040	4800	2080	1160					0.16
B	6	5350	8750	11120	2730	32900	1761					0.31
C	6	18740	19100	13300								0.34
D	10	2960	2660	1580	1420	1800	3020					0.77
E	10	2740	1240	1640	860	860						0.73
F	8	7220	6840	7760	7060	4900	4200	2900	3000	4200	3080	1.24
G	10	4890	6040	8640	25120	5590						0.19
H	9	5340	4720	6320	4740	4580	4460	3590				0.46
I	9	3320	3220	2020	2120	2420	1820	1840				2.86
J	8	18430	16400	11560	7150							0.25
K	10	12520	9060	8960	6580	6060						0.46
L	15	3880	2600	2680	3520							0.48
M	6	4980	3980	2080	1560	1820	940					1.21
N	8	3420	2200	2640	2640	1400						1.15
O	10	1760	2780	2740	3060							1.34
P	18	1380	1200	1100	880							0.95
Q	11	10120	8100	5540	4520							0.34
R	8	240	250	143	357	294						0.27
S	12	1960	1740	1920	1560	1560	1420					0.83
T	8	5440	4520	4780	4360	3520	3260					0.85
U	11	6180	4840	4080	3240	2280	2330					0.59
V	8	4340	3940	3100	4320							0.60
W	9	4960	4880	5380	6220	6580	6260	5480				0.70
X	15											
Y	8	1260	1160	1480	1210							0.25
Z	10	420	40	40								1.30

Other roots 1360 cpm/g dry wt (43.2 g); leaves 4440 (21.8 g); misc. root 2940 (9.6 g); small stem 10560 (59.9 g); large stem 4440 (54.4 g); litter 12,880 (1.1g).

<u>Lycium pallidum</u> - Rock Valley - May 1974 (792,000 cpm ^{14}C fixed)

Root	Depth from surface	Length of root, cm							
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
	cm	cpm/g dry weight							
Main	-	1400	620	300	600	700	700	720	720
A	10	1420	980	540	540	580	620	620	640
B	17	220	240	60	160	140	160		
C	2	280	200	160	220	220			
D	22	480	380	540	956	957	1675		
E	22	360	400	400	160	160			
F	20	200	375	160	100	120	191		
G	29	580	560	560	560	600	660	540	540
H	23	160	106	300					
I	25	220	180	180	120				
J	25	540	560	640	680	560	620	740	800
K	25	200	186						
L	26	240	240	260	220				
M	6 (large)	3680	2720	3740	4260	3580	3660	3340	3700
N	9 (off M)	1040	400	595	538				
O	4 (off M)	1880	1460	1120	1220				

Root	Depth from surface	Length of root, cm						Dry wt of roots
		80-90	90-100	100-110	110-120	120-130	130-140	
	cm	cpm/g dry weight						g
Main	-	800	840	620	520	620	620	80.97
A	10	740	720					2.24
B	17							4.13
C	2							0.72
D	22							0.97
E	22							1.88
F	20							0.55
G	29	580	580					11.26
H	23							0.19
I	25							0.79
J	25	900	620					3.56
K	25							0.15
L	26							1.05
M	6 (large)	3800						14.52
N	9 (off M)							0.33
O	4 (off M)							0.77

Misc. roots 140 cpm/g dry wt (4.2 g); dead crown 60 (62.7 g); small stem 4060 (5.4 g); large stem 3520 (30.9 g); leaves 1440 (5.7 g); litter 1420 (16.2 g).

Table 18, continued

Lycium andersonii - Rock Valley - May 1974 (988,000 cpm ^{14}C fixed)

Root	Depth from surface	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90
	cm	cpm/g dry weight								
Main 1	-	2840	2540	3300	3120	3180	2860	2720	2560	2660
Main 2	-	1360	2020	1960	2380	2580	2680	2520	2520	2320
Main 3	-	3200	3360	4120	4340	3440	3480	3260	3080	2740
A	2	2320	0	0						
B	2	3620	5240	5300	4680	2660	2240			
C	4	1560	1620	2762						
D	7	2400	3540	2540	3000	2480	4180	3840		
E	8	2700	3480	3480	2460	1680	2160	2480	1940	1860
F	6	4240	1500	1040						
G	12	4000	3280	3220	2560					
I	10	3440	2640	3560						
K	2	1500	1180	800	400					
L	3	1500	1140	1280	1240	1500	1440			
M	3	1500	1140	1280	1240	1500	1440			
O	6	4980	4440	3000	2500	3438				
P	1	2900	1820	1540	1500	1320				

Root	Depth from surface	90-100	100-110	110-120	120-130	130-140	140-150	150-160	160-170	170-180	Dry wt of roots
	cm	cpm/g dry weight									g
Main 1	-	2880	2340	2600	2760	2200	2640	2429	1900	1040	28.98
Main 2	-	2220	1700								11.46
Main 3	-	3380	4160								10.23
A	2										0.29
B	2										3.72
C	4										0.52
D	7										2.84
E	8										6.30
F	6										0.46
G	12										0.89
I	10										0.96
K	2										1.11
L	3										0.17
M	3										3.18
O	6										1.33
P	1										1.25

Misc. root 5280 cpm/g dry wt (2.7 g); crown 2320 (7.4 g); small stem 3620 (37.8 g); large stem 2830 (54.2g); leaves 800 (15.7 g); litter 4820 (2.27 g).

Table 19. Summary of labeling patterns of the roots from Tables 15 to 18

Species	Date sampled	No of high S.A.** roots	No of low S.A.** roots	No of non-labeled roots	No of medium S.A.** roots
		Mercury Valley			
Larrea tridentata	Dec. 1973	3	5	0	7
Atriplex confertifolia	"	3	6	0	3
Ambrosia dumosa	"	0	1	0	8
Krameria parvifolia	"	2	9	1	2
Atriplex confertifolia	"	2	0	0	3
Ambrosia dumosa	"	1	3	2	11
Acamptopappus shockleyi	"	4	1	0	4
Larrea tridentata*	"	5	1	0	4
" "	June 1974	0	5	3	0
Atriplex confertifolia	"	0	11	2	2
Ambrosia dumosa	"	0	2	3	8
" "	"	1	3	0	11
Acamptopappus shockleyi	"	0	3	0	10
		Rock Valley			
Lycium andersonii	Dec. 1973	5	3	4	5
Grayia spinosa	"	2	3	0	9
Ceratoides lanata	"	8	1	0	0
Atriplex confertifolia	"	2	0	1	
Lycium pallidum	"	2	5	0	7
Lycium andersonii	May 1974	0	4	1	11
Grayia spinosa	"	0	3	0	11
Ceratoides lanata	"	5	3	1	
Atriplex confertifolia	"	2	4	0	6
Lycium pallidum	"	0	5	3	8

*Some roots appeared to have a pulse or a demarcation in the distribution of the ^{14}C.

**S.A. is specific activity of ^{14}C.

LITERATURE CITED

BAMBERG, S. A., T. ACKERMAN, H. O. HILL, H. W. KAAZ, and A. VOLLMER. 1974a. Perennial plant populations. Pages 30-35 *in* F. B. Turner and J. F. McBrayer, eds. Rock Valley Validation Site report. US/IBP Desert Biome Res. Memo. 74-2. Utah State Univ., Logan. 64 pp.

BAMBERG, S. A., A. WALLACE, G. E. KLEINKOPF, A. VOLLMER, and B. S. AUSMUS. 1974b. Plant productivity and nutrient interrelationships of perennials in the Mohave Desert. US/IBP Desert Biome Res. Memo. 74-8. Utah State Univ., Logan. 16 pp.

BAMBERG, S., A. WALLACE, G. KLEINKOPF, and A. VOLLMER. 1973. Plant productivity and nutrient interrelationships of perennials in the Mohave Desert. US/IBP Desert Biome Res. Memo. 73-10. Utah State Univ., Logan. 52 pp.

BEATLEY, J C. 1969. Vascular plants of the Nevada Test Site, Nellis Air Force Range, and Ash Meadows. USAEC Biology and Medicine TID-4500, UCLA 12-705.

CALDWELL, M. M., E. J. DEPUIT, O. A. FERNANDEZ, H. H. WIEBE, and L. B. CAMP. 1974. Gas exchange, translocation, root growth, and soil respiration of Great Basin plants. US/IBP Desert Biome Res. Memo. 74-9. Utah State Univ., Logan. 32 pp.

EDNEY, E. B., J. F. MCBRAYER, P. J. FRANCO, and A. W. PHILLIPS. 1974. Distribution of soil arthropods in Rock Valley, Nevada. US/IBP Desert Biome Res. Memo. 74-32. Utah State Univ., Logan. 5 pp.

FRECKMAN, D. W., S. A. SHER, and R. MANKAU. 1974 Biology of nematodes in desert ecosystems. US/IBP Desert Biome Res. Memo. 74-35. Utah State Univ., Logan. 10 pp.

HARVEY, R. A. 1972. An assessment of the seasonal growth on some desert shrubs subjected to chronic low intensity gamma radiation. Pages 12-48 *in* A. Wallace and E. M. Romney, Radioecology and ecophysiology of desert plants at the Nevada Test Site. USAEC Rep. TID-25954. 439 pp.

KOLLER, E. 1970. Determination of fundamental plant parameters controlling carbon assimilation and transpiration by the null-point compensating system (improved version). USAEC Rep. UCLA 12-797. 28 pp.

TURNER, F. B. (Coordinator) et al. 1973. Rock Valley Validation Site report. US/IBP Desert Biome Res. Memo. 73-2. Utah State Univ., Logan. 211 pp.

TURNER, F. B., ed. 1975. Rock Valley Validation Site report. US/IBP Desert Biome Res. Memo. 75-2. Utah State Univ., Logan.

TURNER, F. B., and J. F. MCBRAYER, eds. 1974. Rock Valley Validation Site report. US/IBP Desert Biome Res. Memo. 74-2. Utah State Univ., Logan. 64 pp.

WALLACE, A., S. A. BAMBERG, and J. J. CHA. 1974. Quantitative studies of roots of perennial plants in the Mojave Desert. Ecology 55(5):1160-1162.

WALLACE, A., S. A. BAMBERG, and J. J. CHA. Partitioning of photosynthetically fixed ^{14}C in perennial plants of the northern Mohave Desert. IBP Interbiome Symposium (1973). The belowground ecosystem: A synthesis of plant-associated processes. Fort Collins, Colo. (In press)

WEST, N. E., and C. GUNN. 1974. Phenology, productivity, and nutrient dynamics of some cool desert shrubs. US/IBP Desert Biome Res. Memo. 74-7. Utah State Univ., Logan. 6 pp.

APPENDIX A

Correction of Table 9 in 1974 Progress Report, RM 74-8. Carbon input by dominant shrubs based on net CO_2 exchange as a function of leaf dry weight (kg/ha), Rock Valley, 1972 and 1973

Species	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	% change of 73 over 72
Ambrosia dumosa	72		8.03	60.95	50.29	18.68	3.70							141.01	
	73			17.35	80.78	126.79	79.87	17.33	7.07	1.46				329.21	133
Krameria parvifolia	72			1.47	8.89	24.27	20.58	5.18	4.60	6.84	4.27			74.97	
	73				8.21	48.48	49.07	37.44	26.76	19.00	3.19			190.84	155
Larrea tridentata	72	4.61	10.32	30.41	27.20	12.26	4.29	2.89	2.85	4.37	5.48	5.00	3.33	97.11	
	73	4.09	6.02	11.68	32.15	49.22	37.62	12.62	8.70	9.41	7.92	4.91	2.74	153.67	58
Lycium andersonii	72		11.35	45.15	17.58	2.72								76.49	
	73		14.03	179.43	193.73	135.42	61.12	6.48						587.73	684
Lycium pallidum	72		3.15	13.19	8.47	1.60								26.28	
	73		19.05	81.84	72.42	43.62	16.06	3.85						235.63	797
Totals	72													415.86	
	73													1497.08	260